Controlled Synthesis and Magnetic Properties of CoPt Nanoparticles

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Motivation and Outline

- Equiatomic CoPt and FePt alloy films with an Li2-ordered structure (face-centered tetragonal, FCT phase) have been attractive as ultrahigh-density magnetic recording media.
- Due to the fact that formation of face-centered tetragonal (FCT) Co-Pt phase was very sensitive to the composition, controlled synthesis of FCC Co50Pt50 particles becomes very necessary for obtaining ordered FCT Co-Pt particles with higher coercivity and high Ku.
- Controlled synthesis and assembly can be used to fabricate CoPt nanoparticles into functional devices for future nanomagnetic applications.
- Controlled FePt particles and assembly have been reported by S.H. Sun (IBM). (J. Phys. Chem. B 2003, 107, 5419-5425).

Polyol reduction technique

Superhydride Reduction

Magnetic hysteresis loops for CoPt nanoparticles as-made and after annealing at different temperatures under Ar+H2 for 1 hr.

Temperature Dependence of Coercivity for CoPt nanoparticles annealed at 650°C.

Fit the Temperature Dependence of the Coercivity to Sharrock's Law

From the fit parameters,*

\[ K_u = M_H \cdot M_s = 1.7 \times 10^7 \text{ erg/cm}^3 \]

\[ V = 4.3 \times 10^{-6} \text{ cm}^3 = (7.6 \text{ nm})^3 \]

The reported bulk value of \( K_u \) is 4.9 \( \times 10^7 \) erg/cm².

Conclusions

- 8 nm CoPt magnetic particles were synthesized by superhydride reduction of CoCl₂ and Pt(acac)₂ at high temperature. By superhydride (LiBEt₃H) reduction, the final CoPt composition was readily tuned. This controlled synthesis and assembly can be used to fabricate CoPt nanoparticle-based functional devices for future nanomagnetic applications.
- These as-prepared CoPt particles were well dispersed in hydrocarbon solvents, showed disordered face-centered cubic (fcc) lattice and were superparamagnetic.
- The ordered FCT Co-Pt structure was obtained by annealing at temperatures ranging from 600°C to 700°C under an inert atmosphere (N₂) or under (Ar and 5% H₂) atmosphere. XRD patterns showed that the Li₂-structure peaks were found after annealing higher than 600°C for all the samples, indicating an ordered fct (Li₂) Co-Pt phases. The coercivity (Hc) of the annealed magnetic particles arrays increased with increasing annealing temperatures and times.
- The time decay of remanence coercivity at different temperatures was measured and fitted to Sharrock’s formula and the thermal stability of the annealed particles arrays was discussed.

This work has been supported by the NSF Materials Research Science and Engineering Center award number DMR-0604247 and DMR-0203985. Any questions or comments, please contact jeon@uta.edu.